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Influence of Antineoplastic Therapy on Function of the Masticatory System, Tooth Development, and Cariogenic Status: A Case Report

Ulla Pajari, DDS, PhD, Aune Raustia, DDS, PhD, Juhani Pyhtinen, MD, PhD, and Marjatta Lanning, MD, PhD

Antineoplastic therapy causes developmental disturbances in the dental enamel and root if children are treated during tooth development. Increased caries activity has also been reported. The effect of anticancer therapy on the function of the masticatory system (i.e., jaws, dentition, masticatory muscles) is not well known. A case report of a 9-year-old girl with right auricular rhabdomyosarcoma is presented. She received irradiation of 50 Gy to the right auricular area and chemotherapy.

A year and a half after cessation of cancer therapy, she was disease free and the clinical stomatognathic examination combined with electromyogram (EMG) registration of the masseter and temporal muscles and magnetic resonance imaging (MRI) examination of the temporomandibular joints (TMJ) revealed a strongly restricted mouth opening capacity, painful right TMJ, and flattened head of the right mandibular condyle. Muscle atrophy in the right masseter muscle was clearly visible but EMG activities of the masseter and temporal muscles, however, were higher on the right than on the left.

More severe developmental defects, and worse gingival and cariological health were observed on the right side than on the left side. She developed 12 carious lesions and all the lesions were on the right maxilla or mandible or on anterior teeth. The left side was not affected. Intensive prophylactic dental care after cancer treatment is important in order to prevent caries and gingival inflammation. Stomatognathic treatment (i.e., management of occlusal and dysfunctional problems) may improve the mouth opening capacity and relieve pain.

Key words: cancer, tooth, developmental defect, caries, TMJ, masticatory muscles

INTRODUCTION

Developmental defects of the tooth enamel and root are obvious and well documented after antineoplastic therapy [1–6]. Developmental defects are related to the therapy used: irradiation causes defects, but children with only chemotherapy also have more enamel defects and root disturbances in their teeth than healthy children [3]. Radiation dose affects the degree of developmental abnormalities. Doses as low as 0.72–1.22 Gy to dental arches have been shown to cause mild developmental defects in both enamel and root [7]. The age of the patient at diagnosis is more important than therapy [7]. Large doses of irradiation cause permanently reduced salivary flow and increased caries activity. Ten gray irradiation during bone marrow transplantation has also reduced salivary flow below the normal range and caused craniomandibular dysfunctions [8].

Rhabdomyosarcoma (RMS) is a rare malignant disease during childhood which represents about 3.5% of all childhood malignancies [9]. Combined-modality therapy of head and neck RMS may cause root stunting, microdontia, hypodontia, and multiple abnormalities. Some patients also developed severe cosmetic and/or functional sequelae [10].

The aim of this paper is to present a case report of a patient with RMS who received high-dose irradiation and chemotherapy during facial growth and tooth development. The child developed an altered function of the masticatory system, altered cariological status, and marked developmental defects in teeth at the irradiated site.

REPORT OF A CASE

Medical History

In the year 1990, at the age of 9 years, the patient was admitted to the Department of Pediatrics, University of Oulu, due to a right auricular botryoid RMS extending intracranially. The tumor could not be totally removed

From the Institute of Dentistry, Departments of Preventive Dentistry and Cariology (U.P.), Prosthetic Dentistry and Stomatognathic Physiology (A.R.), Departments of Diagnostic Radiology (J.P.), and Pediatrics (M.L.), University of Oulu, Oulu, Finland.

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Address reprint requests to Dr. U. Pajari, Institute of Dentistry, Aapistie 3, 90220 Oulu, Finland.

surgically and she was treated according to the CCG 631 protocol containing vincristine, actinimycin-D, triple intrathecal medication with cytosine arabinoside, methotrexate and hydrocortisone, and irradiation to the field involved. The radiation dose was 50 Gy in 28 fractions during 6 weeks. The teeth and mandible condyle on the right side were in the irradiation field. The dose on the opposite side was 15–18 Gy. The cytostatic treatment continued until 2 years after diagnosis and now she is disease free.

Dental History

Initial dental examination was performed at the Institute of Dentistry, University of Oulu, after the cancer diagnosis, before irradiation therapy. She had sound mixed dentition and her cariological and gingival status was good. The panoramic radiograph (Ortopantomograph OP 100, Instrumed, Finland) showed that permanent teeth were developing in a normal way (Fig. 1A) and there were no problems in occlusion.

A year and a half after cessation of cancer therapy, the main problem was a markedly reduced mouth opening capacity and the girl was referred to stomatognathic consultation. In a panoramic radiograph, the shorter ramus and larger gonial angle of the mandible on the right compared to left side were noted (Fig. 1B) and facial asymmetry was visible.

At this time, clinical stomatognathic examination was performed and included measurement of the ranges of movements of the mandible, function of the temporomandibular joints (TMJ), palpation of the TMJs and masticatory muscles, and recording of pain on movement of the mandible. Palpation tenderness was registered in the right TMJ palpated laterally and dorsally and also in the masseter, medial and lateral pterygoid, and posterior digastric muscles only on the right side. Maximal mouth opening was restricted 23 mm (normal > 40 mm), but lateral movement to the right (9 mm), to the left (7 mm), and protrusion movement (movement forwards) (8 mm) were normal (>6 mm). The mandible deviated strongly to the right on mouth opening but no pain was recorded during any movements.

The electromyogram (EMG) measurements of the masseter and temporal muscles were performed using a multichannel device (Myosystem 1000, Noraxon, Finland) interfaced to a microcomputer with an A/D converter system [11]. The signals were filtered between 25–400 Hz, after which full wave rectification and integration were deployed before A/D convention. The integrated EMG signals were analyzed by means of system software (Myosoft 1000, Noraxon, Finland). The muscular activities were recorded during maximal voluntary biting in intercuspidation and laterotrusion and protrusion movements and during chewing pieces of almond. The patient was seated in a chair with the head in an upright position during the measurements. The surface electrodes were placed bilaterally on the superficial masseter and anterior temporal muscles. Muscular activity was expressed in uVs and was calculated from the figure obtained from 10 seconds of muscle action during biting in intercuspidation and 15 seconds of chewing. Electric activities (uVs) of the right masseter muscle were higher than those of the left muscle during all movements (Fig. 2A) and the same was also noted in the right temporal muscle, except during biting laterotrusion to the left and chewing (Fig. 2B).

Due to restricted mouth opening and painful right TMJ, magnetic resonance imaging (MRI) examination of TMJs was performed with a 1.0 T supraconducting unit (Magneton, Siemens, Erlangen, Germany) using a TMJ surface coil. Coronal MRI images revealed obvious muscle atrophy and a flattened condylar head on the right (Fig. 3). In sagittal images, restricted movement of the condyle was noted in the right TMJ. The disc was seen between articular surfaces and its configuration was normal in the right and left TMJ (Fig. 4A–C). A small anterior osteophyte was seen on the left condylar head and its movement was slightly restricted (Fig. 4D). No difference was noted in signal intensity of the spongy bone between the right and left condyle and ramus.

During 3½ years, she had received 12 fillings for carious lesions on the right mandible or maxilla and front teeth. The mean score of decayed, missed, and filled teeth is 1.5 for the area the girl lives in [12]. There were also many superficial carious enamel lesions, which did not need to be restored yet. No affected teeth were found in the left mandible or maxilla. The salivary tests were positive for *Candida albicans* (Oricult N®; Orion Diagnostica, Espoo, Finland) and increased lactobacilli count = 10^6 CFU/ml (Dentocult LB®; Orion) and *Streptococcus mutans* count = $10^{5\text{-}6}$ CFU/ml (Dentocult SM®; Orion) were detected. The stimulated salivary flow was in the normal range (5 ml/5 minutes) and buffer capacity of the saliva was moderate (4.5–5.5; Dentobuff strip®; Orion). The gingiva on the right side showed heavy plaque accumulation and gingivitis.

In the panoramic radiograph, the root development of first and second premolars and second molars had stopped. The effect is most clearly seen in the right side of the mandible where she received the irradiation therapy of 50 Gy (Fig. 1B). The restorations are not visible in Figure 1B because they are nonmetallic restorations. Instructions for prophylactic dental care including fluoride prophylaxis and muscular exercises for the lower jaw were given [13].

DISCUSSION

As reported earlier, also this case clearly showed arrested tooth development after irradiation. Worse cariological and gingival status on the more irradiated right side than the opposite side is interesting, but not unex-

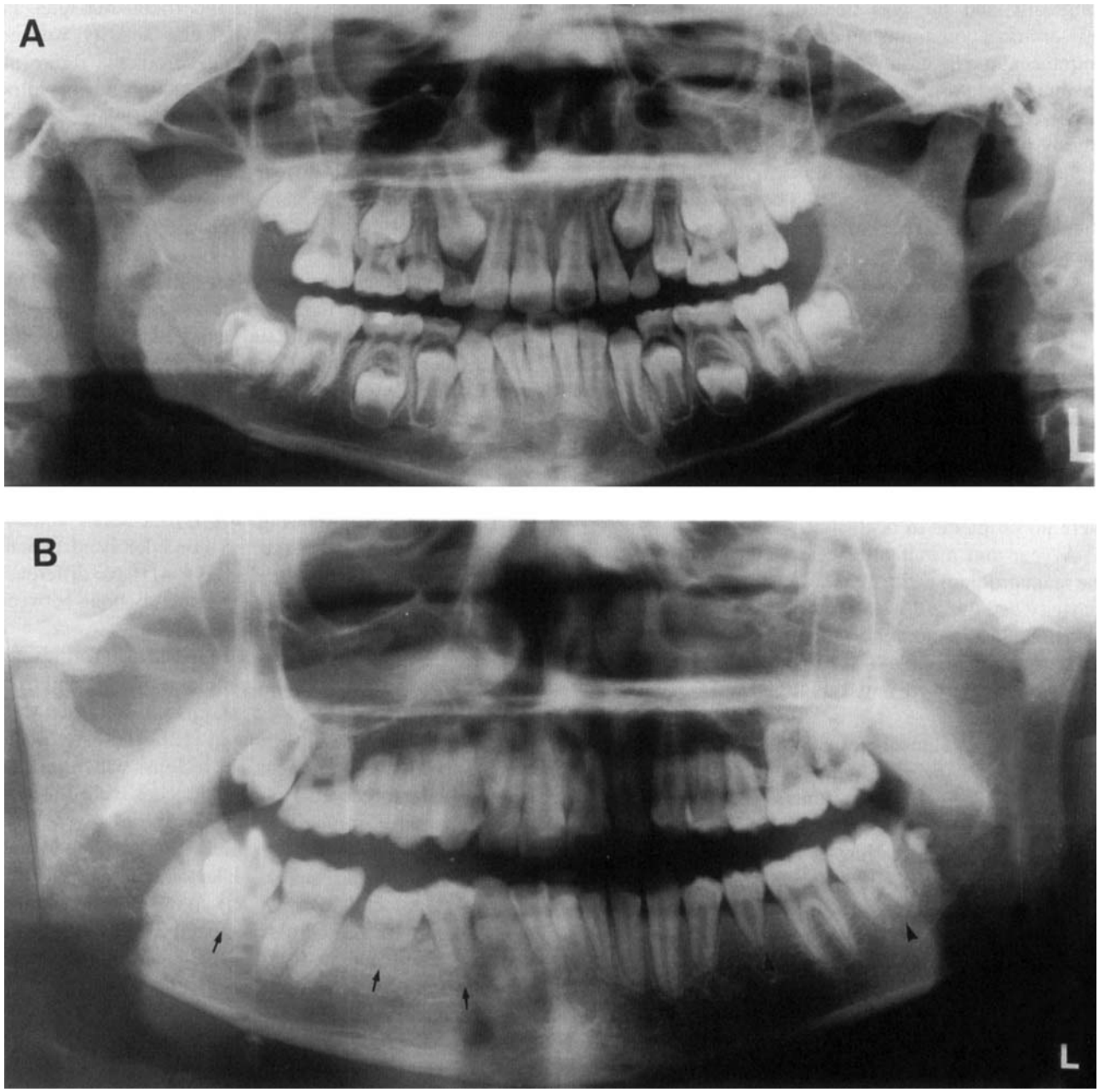

Fig. 1. Panoramic radiographs. A: At cancer diagnosis. All teeth are developing in a normal way. B: Three years after irradiation therapy, a shortened ramus and larger gonial angle on the right than on the left side are seen. The development of premolars and second molars is more disturbed on the right side with irradiation of 50 Gy (arrows) than on the left side with irradiation of 15–18 Gy (arrowheads).

pected. Total salivary flow and buffer capacity were about normal, because irradiation therapy mostly affected salivary glands on the right side. The elevated microbial counts in saliva point to the importance of prophylactic dental care. In patients with reduced mouth opening capacity, restorative dental treatment is very difficult to perform and extractions after irradiation of 50 Gy may be contraindicated because of future osteoradionecrosis [14]. Extensive prophylactic dental care may save the teeth and it can be supposed that muscular exercises for the lower jaw may be helpful in keeping the ranges of the mandibular movements as wide as possible in these patients.

MRI, as a nonharmful imaging method, made possible the most accurate examination of the soft tissue structure of the TMJ [15,16] and the detection of masticatory mus-

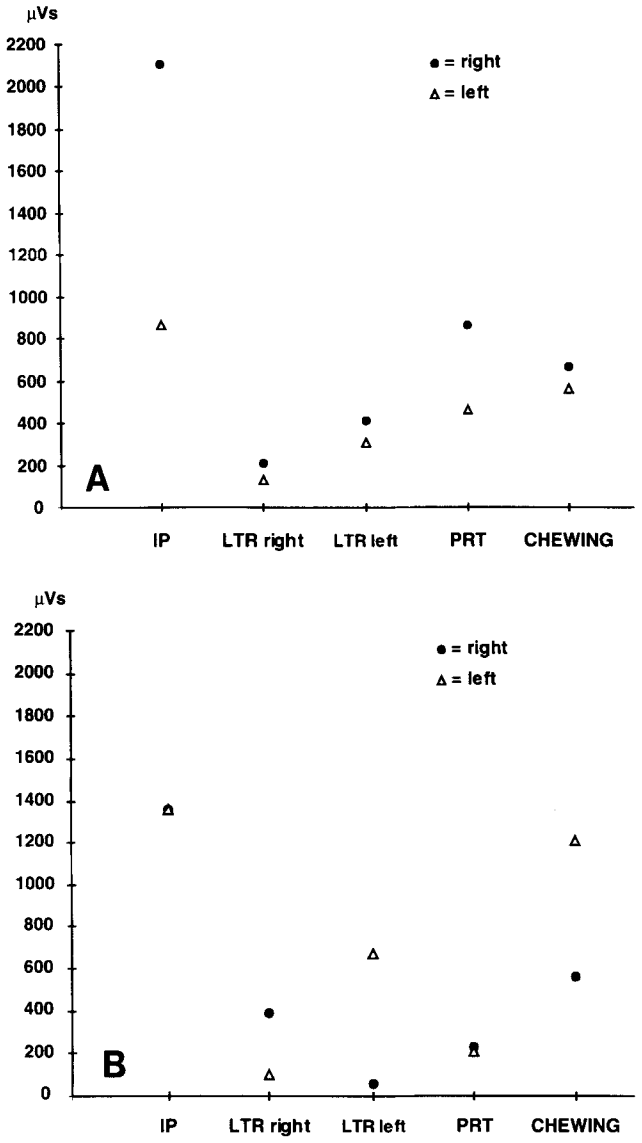

Fig. 2. EMG activities (uVs) of the masseter **(A)** and anterior temporal **(B)** muscles during biting in intercuspidation (IP), laterotrusion (LTR right, left), protrusion (PTR), and chewing.

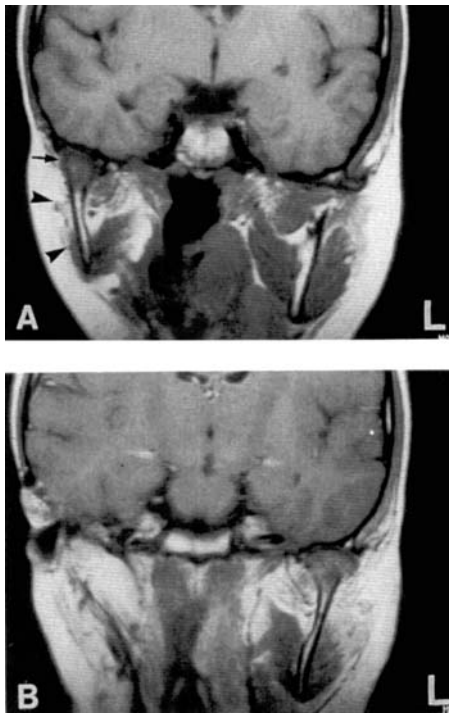

Fig. 3. Coronal spin echo T1-weighted MRI images (TR 690 ms, TE 15 ms, 5 mm thick slices) through the TMJs revealed obvious muscle atrophy (arrowheads) and flattened condylar head (arrow) on the right **(A)** compared to the left side **(B).**

cle disease such as atrophy, fatty replacement, and fibrosis [17,18].

It has been noted that both irradiation and chemotherapy in pediatric cancer patients induce long-term alterations in connective and muscular tissues, resulting in inflammation and fibrosis [8]. It is known that when radiation therapy is combined with surgery and/or chemotherapy, the risk of late complications is likely to increase, involving muscles and nerves with the time following radiation [19]. This can lead to the malocclusion and reduced function of the masticatory muscles and TMJ, also noted here in the form of the flattened condylar head on the right side and strongly restricted movement of the right condyle which is due to altered growth capability and fibrosis of muscle and joint structures (Fig. 4A,B). Due to abnormal function of the mandible, the pathological change on the contralateral mandibular condyle (osteophyte) was seen (Fig. 4C,D).

Although obvious muscle atrophy of the right masseter muscle obtained by MRI was distinguishable, the EMG activity recorded for this muscle was higher than that of the left one during all movements of the mandible. It can be suggested that muscular exercises of the lower jaw are useful to keep or maybe to increase the functional capacity of the masticatory system.

CONCLUSIONS

As a result of panoramic radiograph soon after cancer diagnosis and prior to irradiation therapy, it could be suggested that arrested root development is due to cancer therapy. Chemotherapy affects all teeth, but arrested root development was clearly seen on the right side where the irradiation dose was high. The worse gingival and cariological status on the right side compared to the left is interesting and points to the importance of prophylactic dental care, especially in that region.

The most important aspect of this paper may be the clinical stomatognathic examination. EMG of the masti-

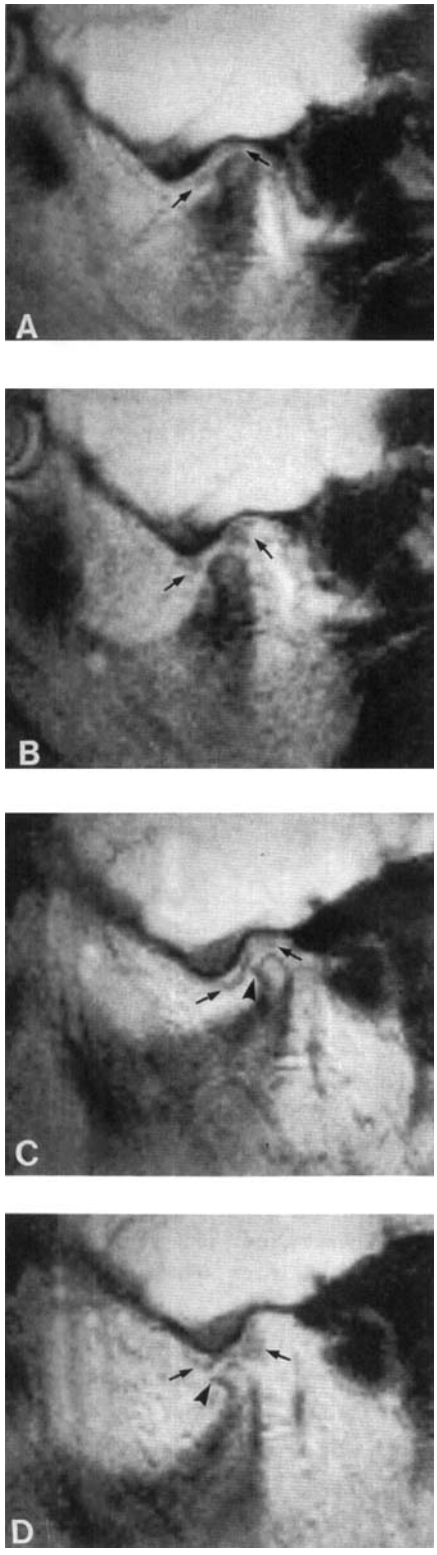

Fig. 4. Sagittal gradient echo MRI images of the TMJs (TR 280 ms, TE 15 ms, flip angle 40°, 4 mm thick slices). **A:** The right TMJ at mouth closed and open **(B)** positions. The movement of the mandibular condyle is strongly restricted. The biconcave disc is seen at a normal position between articular surfaces (arrows). **C:** The left TMJ at mouth closed and open **(D)** positions. The disc is at normal position between articular surfaces (arrows). A small anterior osteophyte is distinguishable on the condylar head (arrowhead). The movement of the mandibular condyle is slightly restricted (D).

catory muscles or MRI of the TMJs has not been reported earlier among children with cancer. The examinations give new information on the influence of antineoplastic therapy on the anatomical structure and function of the masticatory system and stomatognathic treatment. For instance, muscular exercises or splint therapy may relieve pain and help to keep the range of mandibular movements as wide as possible.

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